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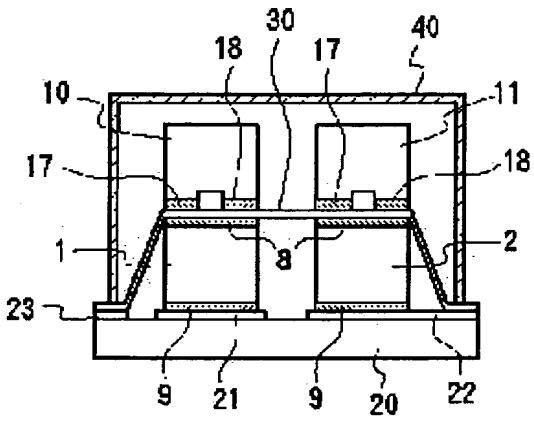
(54) LADDER-TYPE FILTER

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a highly reliable ladder-type filter in which a substrate can be miniaturized and whose manufacture is simple.
SOLUTION: Series resonators 1 and 2 which are loaded on the substrate 20 and which use vibration in the lengthwise direction, a wiring film 30 where connection electrodes are formed on both sides and parallel resonators 10 and 11 which are stacked and arranged on the series resonators through the wiring film and which use lengthwise vibration are installed. The lengthwise direction center parts of the lower electrodes of the series resonators 1 and 2 are electrically fixed on the first pattern electrode of the substrate 20. The lengthwise direction center parts of the upper electrodes of the series resonators 1 and 2 are electrically connected to the first connection electrode of the wiring film 30. The lengthwise direction center parts of the first electrodes in the parallel resonators 10 and 11 are electrically connected on the second connection electrode of the wiring film 30. The lengthwise direction center parts of the second electrodes of the parallel resonators 10 and 11 are electrically connected onto the third connection electrode of the wiring film 30. The second connection electrode of the wiring film 30 is connected to the second pattern electrode of the substrate 20 and the third connection electrode of the wiring film 30 is connected to the third pattern electrode of the substrate 20.



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CLAIMS

[Claim(s)]
[Claim 1] a top face -- the 1- with the series resonance child using die-length vibration which has the substrate with which the 3rd pattern electrode was formed, and the electrode which is carried on a substrate and counters the vertical side of a piezo electric crystal The 2nd connection electrode through which the 1st connection electrode is formed in a rear face, and it flows with the 1st connection electrode on a front face, With the wiring film with which the 3rd connection electrode was formed, and the parallel resonance child using die-length vibration which puts on a series resonance child, is arranged through a wiring film, and has the 1st and 2nd electrode on the inferior surface of tongue of a piezo electric crystal The 1st connecting means which carries out connection immobilization of the die-length direction center section of a series resonance child's inferior-surface-of-tongue electrode electrically on the 1st pattern electrode of a substrate, The 2nd connecting means which carries out connection immobilization electrically to the 1st connection electrode of a wiring film on the die-length direction center section of a series resonance child's top-face electrode, The 3rd connecting means which carries out connection immobilization of the die-length direction center section of a parallel resonance child's 1st electrode electrically on the 2nd connection electrode of a wiring film, The 4th connecting means which carries out connection immobilization of the die-length direction center section of a parallel resonance child's 2nd electrode electrically on the 3rd connection electrode of a wiring film, It is the ladder mold filter characterized by connecting the 2nd connection electrode of a preparation and the above-mentioned wiring film to the 2nd pattern electrode of a substrate, and connecting the 3rd connection electrode of the above-mentioned wiring film to the 3rd pattern electrode of a substrate.
[Claim 2] A piezo electric crystal layer is a ladder mold filter according to claim 1 characterized by carrying out polarization in the die-length direction of a base including two external electrodes formed so that the above-mentioned series resonance child may be connected with the above-mentioned internal electrode by turns in the vertical side where the base of the shape of a column which carried out the laminating of a piezo electric crystal layer and the internal electrode, and a base counter in the die-length direction.
[Claim 3] A piezo electric crystal layer is a ladder mold filter according to claim 1 or 2 characterized by carrying out polarization in the die-length direction of a base including two external electrodes formed so that the above-mentioned parallel resonance child may be connected with the above-mentioned internal electrode by turns on the inferior surface of tongue of the base of the shape of a column which carried out the laminating of a piezo electric crystal layer and the internal electrode in the die-length direction, and a base.
[Claim 4] a top face -- the 1- with the series resonance child using die-length vibration which is carried on the substrate with which the 3rd pattern electrode was formed, and a substrate, has the 1st and 2nd electrode on the inferior surface of tongue of a piezo electric crystal, and has the 2nd electrode and the 3rd flowing electrode on the top face With the parallel resonance child using die-length vibration which has the electrode which puts on a series resonance child, is arranged and counters the vertical side of a piezo electric crystal The 1st and 2nd connecting means which carries out connection immobilization of the die-length direction center section of the 1st and 2nd electrode a series resonance child's inferior surface of tongue electrically at the 1st of a substrate, and the 2nd pattern electrode, respectively, The 3rd connecting means which carries out connection immobilization of the die-length direction center section of the 3rd electrode a series resonance child's top face electrically with the die-length direction center section of a parallel resonance child's inferior-surface-of-tongue electrode, The ladder mold filter characterized by having the 4th connecting means which connects electrically the die-length direction center section of a parallel resonance child's top-face electrode with the 3rd pattern electrode of a substrate.

[Claim 5] A piezo electric crystal layer is a ladder mold filter according to claim 4 characterized by carrying out polarization in the die-length direction of a base including three external electrodes formed so that the above-mentioned series resonance child may be connected with the above-mentioned internal electrode by turns in the vertical side where the base of the shape of a column which carried out the laminating of a piezo electric crystal layer and the internal electrode, and a base counter in the die-length direction.
[Claim 6] A piezo electric crystal layer is a ladder mold filter according to claim 4 or 5 characterized by carrying out polarization in the die-length direction of a base including two external electrodes formed so that the above-mentioned parallel resonance child may be connected with the above-mentioned internal electrode by turns in the vertical side where the base of the shape of a column which carried out the laminating of a piezo electric crystal layer and the internal electrode, and a base counter in the die-length direction.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the ladder mold filter using the piezoelectric device using die-length vibration.
[0002]
[Description of the Prior Art] Conventionally, the ladder mold filter using the series resonance child and parallel resonance child using the die-length direction oscillation mode is proposed (JP,9-270668,A). This ladder mold filter is equipped with the substrate with which the object for an input, the object for an output, and the pattern electrode for a ground were formed, the series resonance child and parallel resonance child carried in the top face of a substrate, and the cap pasted up on a substrate so that these resonators may be covered. The series resonance child has the electrode on the side face of the right and left which counter, and connection immobilization of these electrodes is carried out by the object for an input and the pattern electrode for an output, and electroconductive glue of a substrate. Moreover, a parallel resonance child has an electrode in a vertical side, connection immobilization of the inferior-surface-of-tongue electrode is carried out by electroconductive glue at the pattern electrode for an output of a substrate, and the top-face electrode is electrically connected by the pattern electrode for a ground and metal wire of a substrate. Thus, if the parallel arrangement of a series resonance child and the parallel resonance child is carried out to a plane on a substrate, the arrangement tooth space of a substrate will become large. In the case of the ladder mold filter which constituted two or more steps of ladders especially, since a series resonance child and a parallel resonance child are prepared two or more pieces, respectively, there is a fault to which a substrate becomes much more large-sized, and becomes large-sized also as a ladder mold filter.
[0003] In order to cancel such a fault, what has accumulated and stationed the parallel resonance child on a series resonance child in the above-mentioned official report is proposed (refer to drawing 6 of the above-mentioned official report, and drawing 9). In this case, the series resonance child has the electrode like the above on the side face of the right and left which counter, and connection immobilization of these electrodes is carried out by the object for an input and the pattern electrode for an output, and electroconductive glue of a substrate. Moreover, a laminating is carried out on a series resonance child with electroconductive glue, it pastes up, and the top-face electrode is electrically connected by the pattern electrode for a ground and metal wire of a substrate so that a parallel resonance child may have an electrode in a vertical side and the inferior-surface-of-tongue electrode may flow with the electrode of a series resonance child's output side. In this case, since a series resonance child and a parallel resonance child are accumulated up and down, the arrangement tooth space of a substrate becomes small and can constitute a small ladder mold filter.
[0004]
[Problem(s) to be Solved by the Invention] However, since it is the piezoelectric device to which a series resonance child has an electrode on a side face on either side in the case of the ladder mold filter of the above-mentioned structure, it will approach with the inferior-surface-of-tongue electrode of the parallel resonance child who pastes up not only the electrode of a series resonance child's output side but the electrode of an input side on it. Therefore, when connecting a parallel resonance child's inferior-surface-of-tongue electrode, and the electrode of a series resonance child's output side with electroconductive glue, there was a possibility that a parallel resonance child's inferior-surface-of-tongue electrode might flow through the electrode of a series resonance child's input side. Therefore, the processing according to rank was needed so that a parallel resonance child's inferior-surface-of-tongue electrode and the electrode of a series resonance child's input side might not flow, and there was a problem which raises a manufacturing cost. Moreover, since there are an electrode of a series resonance child's output side and a parallel resonance

child's inferior-surface-of-tongue electrode pasted up on it in the rectangular direction, in order to connect these electrodes certainly, additional processing in which the electrode of an output side and the flowing electrode for connection are formed in a series resonance child's top face may be needed, and much more cost rise may have been caused. Similarly, since there are also an object for the input of the electrode of a series resonance child's input side and an output side and a substrate and a pattern electrode for an output in the rectangular direction, in having pasted up as it is, adhesion area is small. Therefore, in order to connect these electrodes certainly, electroconductive glue needed to be applied by dispensing etc. and productivity may have been reduced.

[0005] Then, while the purpose of this invention can miniaturize a substrate, it is easy to manufacture and it is to offer a reliable ladder mold filter.

[0006]

[Means for Solving the Problem] The above-mentioned purpose is attained by invention according to claim 1 or 4. namely, invention according to claim 1 -- a top face -- the 1- with the substrate with which the 3rd pattern electrode was formed With the series resonance child using die-length vibration which has the electrode which is carried on a substrate and counters the vertical side of a piezo electric crystal The 2nd connection electrode through which the 1st connection electrode is formed in a rear face, and it flows with the 1st connection electrode on a front face, With the wiring film with which the 3rd connection electrode was formed, and the parallel resonance child using die-length vibration which puts on a series resonance child, is arranged through a wiring film, and has the 1st and 2nd electrode on the inferior surface of tongue of a piezo electric crystal The 1st connecting means which carries out connection immobilization of the die-length direction center section of a series resonance child's inferior-surface-of-tongue electrode electrically on the 1st pattern electrode of a substrate, The 2nd connecting means which carries out connection immobilization electrically to the 1st connection electrode of a wiring film on the die-length direction center section of a series resonance child's top-face electrode, The 3rd connecting means which carries out connection immobilization of the die-length direction center section of a parallel resonance child's 1st electrode electrically on the 2nd connection electrode of a wiring film, The 4th connecting means which carries out connection immobilization of the die-length direction center section of a parallel resonance child's 2nd electrode electrically on the 3rd connection electrode of a wiring film, It is the ladder mold filter characterized by connecting the 2nd connection electrode of a preparation and the above-mentioned wiring film to the 2nd pattern electrode of a substrate, and connecting the 3rd connection electrode of the above-mentioned wiring film to the 3rd pattern electrode of a substrate.

[0007] invention according to claim 4 -- a top face -- the 1- with the substrate with which the 3rd pattern electrode was formed With the series resonance child using die-length vibration which is carried on a substrate, has the 1st and 2nd electrode on the inferior surface of tongue of a piezo electric crystal, and has the 2nd electrode and the 3rd flowing electrode on the top face With the parallel resonance child using die-length vibration which has the electrode which puts on a series resonance child, is arranged and counters the vertical side of a piezo electric crystal The 1st and 2nd connecting means which carries out connection immobilization of the die-length direction center section of the 1st and 2nd electrode a series resonance child's inferior surface of tongue electrically at the 1st of a substrate, and the 2nd pattern electrode, respectively, The 3rd connecting means which carries out connection immobilization of the die-length direction center section of the 3rd electrode a series resonance child's top face electrically with the die-length direction center section of a parallel resonance child's inferior-surface-of-tongue electrode, It is the ladder mold filter characterized by having the 4th connecting means which connects electrically the die-length direction center section of a parallel resonance child's top-face electrode with the 3rd pattern electrode of a substrate.

[0008] In invention concerning claim 1, a series resonance child is carried on a substrate, and through a wiring film, a parallel resonance child puts and is stationed on it. Therefore, compared with the case where the series resonance child and the parallel resonance child have been stationed on a substrate at the plane, the arrangement tooth space of a substrate becomes small and can constitute a small ladder mold filter. Moreover, since are the resonator which has an electrode in a vertical side, the inferior-surface-of-tongue electrode is made to meet on the 1st pattern electrode of a substrate and connection immobilization has been carried out by the 1st connecting means, a series resonance child has trustworthy electrical installation, and mechanical strength is also high. And connection immobilization of the 1st connection electrode of a wiring film is electrically carried out by the 2nd connecting means on a series resonance child's top-face electrode. Since the 1st electrode of a parallel resonance child's inferior surface of tongue is connected by the 3rd connecting means on the 2nd connection electrode of a wiring film and the 2nd electrode of a parallel

resonance child's inferior surface of tongue is further connected by the 4th connecting means on the 3rd connection electrode of a wiring film Connection is easy and it is [that all should just make confrontation connection in the vertical direction] trustworthy. And since the 2nd connection electrode of a wiring film is connected to the 2nd pattern electrode of a substrate and the 3rd connection electrode of a wiring film is connected to the 3rd pattern electrode of a substrate, respectively, electric connection can be made, without using a metal wire etc. Therefore, compared with the case of wire connection, the overall height of a product can be made low. Moreover, although soft electroconductive glue is used in many cases as the 1st connecting means for fixing a series resonance child to a substrate, in performing wirebonding, a supersonic wave escapes through electroconductive glue, and junction becomes difficult. On the other hand, in using a wiring film, there is such no problem. In addition, as the 1st - the 4th connecting means, electroconductive glue can be used, for example. Moreover, as a wiring film, a polyimide wiring film can be used, for example.

[0009] A piezo electric crystal layer may use that by which polarization was carried out in the die-length direction of a base including two external electrodes formed so that it may connect with the above-mentioned internal electrode by turns in the vertical side where the base of the shape of a column which carried out the laminating of a piezo electric crystal layer and the internal electrode, and a base counter in the die-length direction like claim 2 as a series resonance child. Since the piezo-electric longitudinal effect which corresponded is used in the case of such a piezoelectric device of a laminating mold, an electromechanical coupling coefficient can be enlarged compared with the piezoelectric device using the piezo-electric transversal effect from which the direction of polarization, the direction of electric field, and the oscillating direction differ. Similarly, a piezo electric crystal layer may use that by which polarization was carried out in the die-length direction of a base like claim 3 as a parallel resonance child including the base of the shape of a column which carried out the laminating of a piezo electric crystal layer and the internal electrode in the die-length direction, and two external electrodes formed so that it may connect with the above-mentioned internal electrode by turns on the inferior surface of tongue of a base. In the case of the piezoelectric device of a laminating mold, the external electrode for I/O can be easily formed in the 1st page only by devising the direction of a drawer of an internal electrode.

[0010] In invention concerning claim 4, a series resonance child is carried on a substrate, and on it, a parallel resonance child puts and is stationed. Therefore, compared with the case where the series resonance child and the parallel resonance child have been stationed on a substrate at the plane, the arrangement tooth space of a substrate becomes small and can constitute a small ladder mold filter. Moreover, he is a resonator which has the 1st and 2nd electrode on the inferior surface of tongue, and has the 2nd electrode and the 3rd flowing electrode on the top face, since the series resonance child made the inferior-surface-of-tongue electrode meet the 1st of a substrate, and the 2nd pattern electrode and did connection immobilization by the 1st and 2nd connecting means, electrical installation is trustworthy and a mechanical strength is also high [the child]. Since similarly a parallel resonance child's inferior-surface-of-tongue electrode was made to meet on the 3rd electrode of a series resonance child's top face and connection immobilization was carried out by the 3rd connecting means, the bonding strength of a series resonance child and a parallel resonance child also becomes high. Therefore, a ladder mold filter with high endurance can be obtained also to a fall impact etc. In addition, as the 1st - the 3rd connecting means, electroconductive glue can be used, for example. Moreover, as the 4th connecting means, the same wiring film as claim 1 may be used, and a metal wire can also be used.

[0011] Like claim 5, a piezo electric crystal layer can use that by which polarization is carried out in the die-length direction of a base including three external electrodes formed so that a series resonance child may be connected with the above-mentioned internal electrode by turns in the vertical side where the base of the shape of a column which carried out the laminating of a piezo electric crystal layer and the internal electrode, and a base counter in the die-length direction. Furthermore, a piezo electric crystal layer can use that by which polarization is carried out in the die-length direction of a base like claim 6 including two external electrodes formed so that a parallel resonance child may be connected with the above-mentioned internal electrode by turns in the vertical side where the base of the shape of a column which carried out the laminating of a piezo electric crystal layer and the internal electrode, and a base counter in the die-length direction. Thus, as a series resonance child and a parallel resonance child, an electromechanical coupling coefficient can be enlarged by using the piezoelectric device of a laminating mold.

[0012]

[Embodiment of the Invention] Drawing 1 - drawing 8 show the 1st example of the ladder mold filter concerning this invention. This ladder mold filter contains two series resonance children 1 and 2 and two

parallel resonance children 10 and 11, as shown in drawing 4 . In addition, as for a substrate and 30, 20 is [a wiring film and 40] caps.

[0013] The series resonance children 1 and 2 are the same piezoelectric devices using the die-length oscillation mode, and as shown in drawing 5 , they contain the base 3 of a rectangular parallelepiped configuration. A base 3 carries out the laminating of two kinds of piezo electric crystal layers 4a and 4b which consist of piezo-electric ceramic ingredients by turns, and an internal electrode 5 is exposed by turns in the vertical both-sides side of a base 3. As an arrow head P shows to drawing 5 , polarization is carried out to the longitudinal direction of a base 3 so that the polarization shaft of the piezo electric crystal layers 4a and 4b of the both sides of one internal electrode 5 may serve as reverse sense mutually. However, polarization of the both ends of a base 3 is not carried out. The external electrodes 6 and 7 are formed in the vertical side which the internal electrode 5 exposed, and an internal electrode 5 is alternately connected with the external electrodes 6 and 7. The convex conductive base materials 8 and 9 are being fixed to the die-length direction center section (node section) of the external electrodes 6 and 7. The conductive base materials 8 and 9 of this example are stiffened after applying the urethane resin containing a conductive filler by predetermined thickness on the external electrode 6 and 7. In addition, the conductive base materials 8 and 9 are omissible by using with the electroconductive glue mentioned later in common.

[0014] In the above-mentioned series resonance children 1 and 2, the external electrodes 6 and 7 are used as close and an output electrode. Since electric field are impressed between the ****** internal electrodes 5 in the part except the both ends of a base 3 at this time, it becomes activity in piezo-electricity, but since polarization of the base 3 is not carried out at the both ends of a base 3 and the electrode moreover is not formed in the both-ends side of a base 3, electric field are not impressed but it becomes inactive in piezo-electricity. Therefore, by giving a signal between the external electrode 6 and 7, the alternating current electric field of the longitudinal direction of a base 3 are impressed to each piezo electric crystal layers 4a and 4b of the activity section, flexible driving force occurs in each piezo electric crystal layers 4a and 4b, and the fundamental vibration of the die-length oscillation mode is excited by the base 3 as a whole. In addition, although the inert segment was prepared in the both ends of a base 3, this inert segment is not indispensable and is good also considering the base 3 whole as the activity section.

[0015] The parallel resonance children 10 and 11 are the same piezoelectric devices using the die-length oscillation mode, and as shown in drawing 6 , they contain the base 12 of a rectangular parallelepiped configuration. A base 12 carries out the laminating of two kinds of piezo electric crystal layers 13a and 13b which consist of piezo-electric ceramic ingredients as shown in drawing 7 by turns, and an internal electrode 14 is exposed by turns in the whole surface of a base 12. As an arrow head P shows to drawing 6 , polarization is carried out to the longitudinal direction of a base 12 so that the polarization shaft of the piezo electric crystal layers 13a and 13b of the both sides of one internal electrode 14 may serve as reverse sense mutually. However, polarization of the both ends of a base 12 is not carried out. Two external electrodes 15 and 16 are formed in the inferior surface of tongue (in drawing 6 and drawing 7 , vertical reversal is carried out and it has illustrated) which the internal electrode 14 exposed in parallel with a longitudinal direction, and an internal electrode 14 is alternately connected with the external electrodes 15 and 16. In addition, although the slot 19 which extends in the die-length direction of a base 12 is formed among the external electrodes 15 and 16, this slot 19 is not necessarily required of this example. The convex conductive base materials 17 and 18 are being fixed to the die-length direction center section (node section) of the external electrodes 15 and 16. The conductive base materials 17 and 18 of this example are stiffened after applying the urethane resin containing a conductive filler by predetermined thickness on the external electrode 15 and 16. In addition, the conductive base materials 17 and 18 are omissible by using with the electroconductive glue mentioned later in common. The fundamental vibration of the die-length oscillation mode is excited by the principle [be / in the parallel resonance children 10 and 11 / series resonance / 1 and 2 / it / the same].

[0016] It is insulating sheet metal of the rectangle which consists of alumina ceramics, a glass ceramic, a glass epoxy resin, heat resistant resin, etc., and as shown in drawing 8 R> 8, as for the substrate 20, the pattern electrode 21 for an input, the pattern electrode 22 for an output, the pattern electrode 23 for a ground, and the dummy electrode 24 are formed in the top face of a substrate 20 by the technique in which sputtering, vacuum evaporationo, printing, etc. are well-known. The external connection of each pattern electrodes 21-24 is installed through the side edge of a substrate 20 to the rear-face side. Adhesion immobilization of the conductive base material 9 fixed to the external electrode 7 by the side of the series resonance children's 1 and 2 inferior surface of tongue is carried out through electroconductive glue (not shown) at the lands 21a and 22a of the pattern electrode 21 for an input, and the pattern electrode 22 for an output. As electroconductive glue, the epoxy system adhesives which contain Ag filler, for example can be

used. Thereby, the series resonance child's 1 external electrode 7 is connected to the pattern electrode 21 for an input of a substrate 20, and the series resonance child's 2 external electrode 7 is electrically connected to the pattern electrode 22 for an output of a substrate 20, respectively, and it is fixed mechanically. Since the die-length direction center section (node section) is fixed to a substrate 20 and both ends are supported with a substrate 20 and a clearance, especially as for the series resonance children 1 and 2, the series resonance children's 1 and 2 die-length vibration is not checked.

[0017] The wiring film 30 forms two or more connection electrodes 31-34 which consist of copper foil etc. in the front rear face of the insulating film which has the flexibility of a polyimide film etc. As shown in drawing 9 , connection immobilization of the connection electrode 31 on the back is carried out through the conductive base material 8 and electroconductive glue (not shown) which were formed in the center section of the wiring film 30, and were formed on the external electrode 6 of the series resonance children's 1 and 2 top face. The connection electrode 31 on the back has flowed with the surface connection electrode 32 through the through hole electrode 35. The connection electrode 33 for a ground and the connection electrode 34 for an output other than the connection electrode 32 are formed in the front face of the wiring film 30. The connection electrode 33 for a ground has flowed with the electrode 37 by the side of a rear face through the through hole electrode 36 elongation and here to the end section of the wiring film 30. Moreover, the connection electrode 34 for an output has flowed with the electrode 39 by the side of a rear face through the through hole electrode 38 elongation and here to the other end of the wiring film 30. One external electrode 15 of the parallel resonance child 10 is connected to the connection electrode 32 of the wiring film 30 through the conductive base material 17 and electroconductive glue (not shown), and the external electrode 16 of another side is connected to the connection electrode 33 through the conductive base material 18 and electroconductive glue (not shown). Moreover, one external electrode 15 of the parallel resonance child 11 is connected to the connection electrode 33 through the conductive base material 17 and electroconductive glue (not shown), and the external electrode 16 of another side is connected to the connection electrode 34 through the conductive base material 18 and electroconductive glue (not shown). And connection immobilization of the electrode 37 formed in the end section rear face of the wiring film 30 is carried out to the pattern electrode 23 for a ground of a substrate 20 by electroconductive glue etc., and connection immobilization of the electrode 39 formed in the other end rear face of the wiring film 30 is carried out by electroconductive glue etc. at the pattern electrode 22 for an output of a substrate 20.

[0018] On a substrate 20, opening of the wrap cap 40 pastes up resonators 1, 2, 10, and 11 with insulating adhesives (not shown), and the closure of the perimeter of resonators 1, 2, 10, and 11 is carried out. Although the cap 40 of this example carries out press forming of the metal plate, you may be the cap made of resin, or the cap made from a ceramic. In this example, in case cap 40 is pasted up on a substrate 20, the both ends of the wiring film 30 are fastened with the cap 40 and the substrate 20, and it has prevented that the wiring film 30 separates from a substrate 20.

[0019] Since in the case of the ladder mold filter of the above-mentioned example the series resonance children 1 and 2 are fixed on a substrate 20, and the parallel resonance children 10 and 11 put and are stationed through the wiring film 30 on it, compared with the case where the series resonance children 1 and 2 and the parallel resonance children 10 and 11 have been stationed on a substrate 20 at the plane, the arrangement tooth space of a substrate 20 becomes small, and can constitute a small ladder mold filter. Moreover, since are the resonator which has an electrode in a vertical side, the inferior-surface-of-tongue electrode 7 is made to meet the lands 21a and 22a of the pattern electrode 21 for an input of a substrate 20, and the pattern electrode 22 for an output and connection immobilization has been carried out with the conductive base material 9 or electroconductive glue, the series resonance children 1 and 2 have trustworthy electrical installation, and bonding strength's is [the children] high. And fix the parallel resonance children 10 and 11 through the wiring film 30 on the series resonance children 1 and 2, and the connection electrode formed in the front rear face of the wiring film 30 is minded. Since interconnect with the series resonance children 1 and 2 and the parallel resonance children 10 and 11 and interconnect with the parallel resonance children 10 and 11 and the pattern electrodes 22 and 23 of a substrate 20 are performed Since it can connect with a substrate 20, without connection becoming certain and using wirebonding, the effectiveness that-izing of the ladder mold filter can be carried out [the low back] is done so. Furthermore, if it fixes to the wiring film 30 beforehand and the parallel resonance children 10 and 11 are mounted on two-element coincidence on the series resonance child 1 and 2, there is an advantage which can aim at improvement in precision to a location gap and height dispersion of a component. In addition, as shown in drawing 3 , the elastic support object 25 which prevents the series resonance children's 1 and 2 inclination may be fixed on a substrate 20. In this case, it can prevent effectively that adhesion with the series resonance children 1 and 2

and a substrate 20 exfoliates. In addition, since it has rubber elasticity, even if the elastic support object 25 may contact the series resonance children 1 and 2, it is rare [it] to check vibration.

[0020] Drawing 10 - drawing 14 show the 2nd example of the ladder mold filter concerning this invention. This ladder mold filter of that circuit is the same as that of drawing 4 including two series resonance children 50 and 51 and two parallel resonance children 60 and 61. In addition, 70 is a substrate and 80 is a cap.

[0021] The series resonance children 50 and 51 are the same piezoelectric devices using the die-length oscillation mode, and as shown in drawing 12 , they contain the base 52 of a rectangular parallelepiped configuration. A base 52 carries out the laminating of two kinds of piezo electric crystal layers 53a and 53b which consist of piezo-electric ceramic ingredients as shown in drawing 13 by turns, and an internal electrode 54 is exposed by turns in the vertical both-sides side of a base 52. At one piezo electric crystal layer 53a, it is formed so that an internal electrode 54 may be exposed to a top face an end side at the bottom, and by piezo electric crystal layer 53b of another side, it is formed so that an internal electrode 54 may be exposed only to an other end side at the bottom. As an arrow head P shows to drawing 12 , polarization is carried out to the longitudinal direction of a base 52 so that the polarization shaft of the piezo electric crystal layers 53a and 53b of the both sides of one internal electrode 54 may serve as reverse sense mutually. However, polarization of the both ends of a base 52 is not carried out. The external electrode 55 is formed in the top face which the internal electrode 54 exposed, two external electrodes 56 and 57 are formed in an inferior surface of tongue, and an internal electrode 54 is alternately connected with the external electrodes 55, 56, and 57. The internal electrode 54 of piezo electric crystal layer 53a is connected to the external electrode 55 on top and one external electrode 56 at the bottom, and, specifically, the internal electrode 54 of piezo electric crystal layer 53b is connected to the external electrode 57 of another side at the bottom. The convex conductive base materials 58 and 59 are being fixed to the die-length direction center section (node section) of the external electrodes 56 and 57 by the side of an inferior surface of tongue. The conductive base materials 58 and 59 of this example are also stiffened after applying the urethane resin containing a conductive filler by predetermined thickness on the external electrode 56 and 57. In addition, the conductive base materials 58 and 59 are omissible by using with the electroconductive glue mentioned later in common.

[0022] The parallel resonance children 60 and 61 are piezoelectric devices using the die-length oscillation mode which has the same structure as the series resonance children 1 and 2 who showed drawing 5 . That is, as shown in drawing 14 , the base 62 of a rectangular parallelepiped configuration carries out the laminating of two kinds of piezo electric crystal layers 63a and 63b which consist of piezo-electric ceramic ingredients by turns, and an internal electrode 64 is exposed by turns in the vertical both-sides side of a base 62. As an arrow head P shows to drawing 14 , polarization is carried out to the longitudinal direction of a base 62 so that the polarization shaft of the piezo electric crystal layers 63a and 63b of the both sides of one internal electrode 64 may serve as reverse sense mutually. The external electrodes 65 and 66 are formed in the vertical side which the internal electrode 64 exposed, and an internal electrode 64 is alternately connected with the external electrodes 65 and 66. The convex conductive base material 67 is being fixed to the die-length direction center section (node section) of the external electrode 66 at the bottom. In addition, the conductive base material 67 is omissible by using with the electroconductive glue mentioned later in common. In addition, the fundamental vibration of the die-length oscillation mode is excited by the principle as the series resonance children 1 and 2 also with same series resonance children 50 and 51 and parallel resonance children 60 and 61.

[0023] The pattern electrode 71 for an input, the pattern electrode 72 for an output, the pattern electrode 73 for a ground, and bipolar electrodes 74 and 75 are formed in the substrate 70, and bipolar electrodes 74 and 75 have flowed mutually through pattern wiring which is not illustrated in it. On the pattern electrode 71 for an input and bipolar electrode 74 of a substrate 70, connection immobilization of the external electrodes 56 and 57 of the series resonance child's 50 inferior surface of tongue is carried out through the conductive base materials 58 and 59 and electroconductive glue (not shown). Similarly, on the bipolar electrode 75 of a substrate 70, and the pattern electrode 72 for an output, connection immobilization of the external electrodes 56 and 57 of the series resonance child's 51 inferior surface of tongue is carried out through the conductive base materials 58 and 59 and electroconductive glue (not shown).

[0024] Moreover, connection immobilization of the parallel resonance child's 60 inferior-surface-of-tongue electrode 66 is carried out through the conductive base material 67 and electroconductive glue, and connection immobilization of the parallel resonance child's 61 inferior-surface-of-tongue electrode 66 is carried out through the conductive base material 67 and electroconductive glue at the series resonance

child's 50 top-face electrode 55 at the series resonance child's 51 top-face electrode 55. And the parallel resonance children's 60 and 61 top-face electrode 65 is connected with the pattern electrode 73 for a ground through the metal wires 76 and 77, respectively. Thus, the ladder mold filter which has the same circuit structure as drawing 4 can be obtained.

[0025] In addition, although the pattern electrode 73 for a ground was formed in the center section of a substrate 70 and the parallel resonance children's 60 and 61 top-face electrode 65 was connected with the electrode 73 for a ground through the metal wires 76 and 77 in this example, respectively When the pattern electrode 73 for a ground is formed in the edge of a substrate 70, the parallel resonance children's 60 and 61 top-face electrode 65 comrades may be connected with a metal wire, and you may connect with the pattern electrode 73 for a ground with a metal wire from one parallel resonance child's top-face electrode. Furthermore, in order to connect the parallel resonance children's 60 and 61 top-face electrode 65 with the pattern electrode 73 for a ground, it is also possible to replace with the metal wires 76 and 77 and to use the wiring film 30 shown in the 1st example.

[0026] Since the parallel resonance children 60 and 61 have been accumulated and stationed on the series resonance children 50 and 51 like the 1st example in the case of the ladder mold filter of the 2nd example, low area-ization can be attained and a small ladder mold filter can be realized. Moreover, since the metal wires 76 and 77 are used, compared with the 1st example, an overall height may become high a little, but since the parallel resonance children 60 and 61 are directly fixed on the series resonance children 50 and 51, support reinforcement becomes high and the endurance over a fall impact improves. Since the parallel resonance children's 60 and 61 inferior-surface-of-tongue electrode 66 makes the series resonance children's 50 and 51 top-face electrode 55 meet, and it pastes up, and the series resonance children's 50 and 51 inferior-surface-of-tongue electrodes 56 and 57 make the pattern electrodes 71 and 74 of a substrate 70, and 75 and 72 meet and paste up especially, even if it is the die-length oscillation mode component which can support only a center section, bond strength and electric dependability are securable.

[0027] It is not necessary to be a monotonous configuration like a publication in the example, and what equipped the interior with the supporter for holding a series resonance child and a parallel resonance child to stability etc. is [the substrate in this invention may be the concave case where it has a side attachment wall around and] sufficient as it. Although the example using the piezoelectric device of the laminating mold which constituted the die-length oscillation mode component from an above-mentioned example as a whole by carrying out the laminating of two or more piezo electric crystal layers as a series resonance child and a parallel resonance child was explained, the die-length oscillation mode component which does not restrict to this and formed the electrode in both the principal planes of one piezo-electric substrate or one side face is sufficient. Furthermore, the thing using not only a thing but one series resonance child and one parallel resonance child who used two series resonance children and two parallel resonance children, and the thing using three or more series resonance children and three or more parallel resonance children are sufficient as the ladder mold filter of this invention.

[0028]

[Effect of the Invention] Since the series resonance child was carried on the substrate by the above explanation according to invention which relates to claim 1 so that clearly and the parallel resonance child has been accumulated and stationed through a wiring film on it, compared with the case where the series resonance child and the parallel resonance child have been stationed on a substrate at the plane, the arrangement tooth space of a substrate becomes small and a small ladder mold filter can be constituted. Moreover, since all of connection immobilization with a series resonance child and a substrate, the connection between a series resonance child and a wiring film, and connection with a wiring film and a parallel resonance child connect the electrodes which meet by the connecting means of electroconductive glue etc., its electrical installation is easy and trustworthy, and its bonding strength is also high. Furthermore, the dependability of junction can be raised, while being able to make electric connection, without using a metal wire etc. and being able to make the overall height of a product low, since it was made to perform electrical installation of a series resonance child and a parallel resonance child, and the pattern electrode of a substrate using the wiring film.

[0029] Since according to invention concerning claim 4 the series resonance child was carried on the substrate and the parallel resonance child has been accumulated and stationed on it, compared with the case where the series resonance child and the parallel resonance child have been stationed on a substrate at the plane, the arrangement tooth space of a substrate becomes small and can constitute a small ladder mold filter. Moreover, since connection immobilization with a series resonance child and a substrate and connection with a series resonance child and a parallel resonance child connect the electrodes which meet by

the connecting means of electroconductive glue etc., its electrical installation is easy and trustworthy, and they do so the effectiveness that bonding strength is also high.

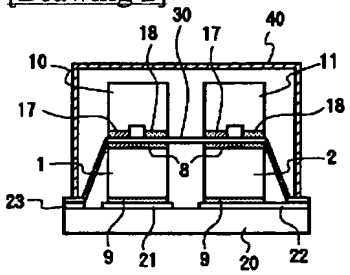
[Translation done.]

* NOTICES *

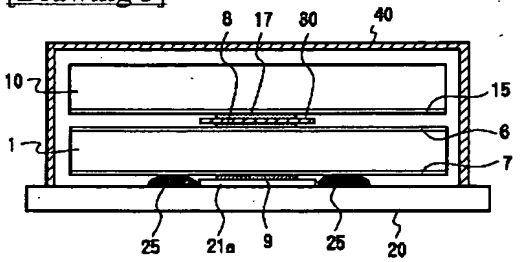
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

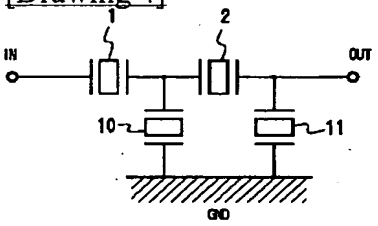
[Drawing 2]



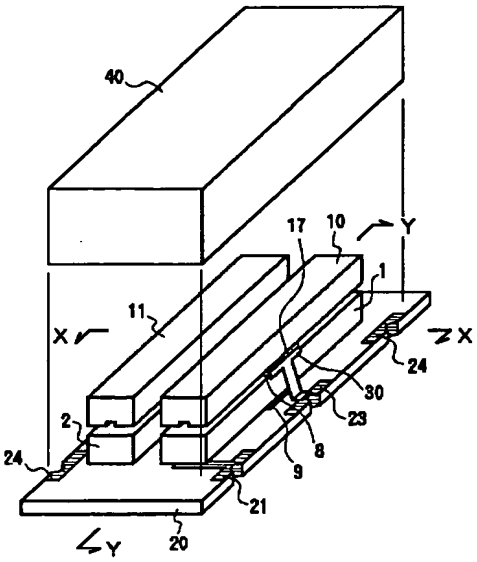
[Drawing 3]



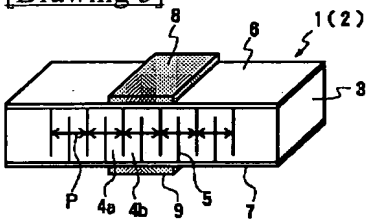
[Drawing 4]



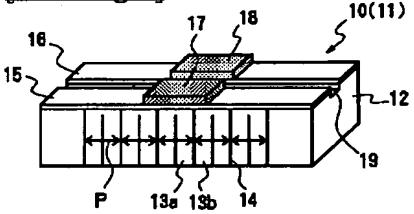
[Drawing 1]



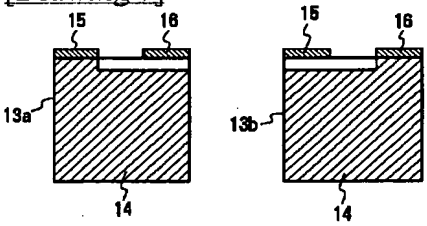
[Drawing 5]



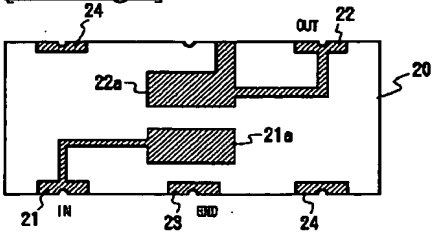
[Drawing 6]



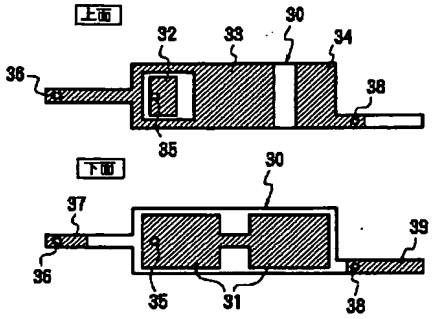
[Drawing 7]



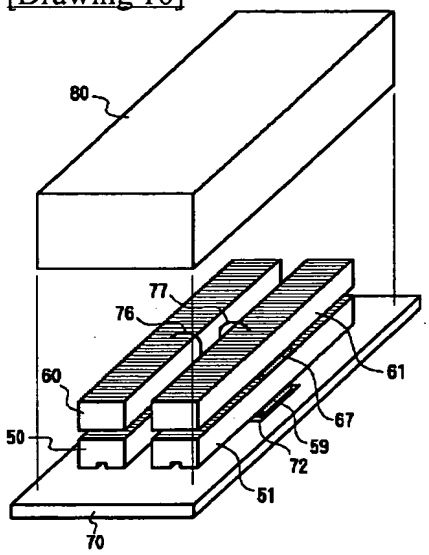
[Drawing 8]



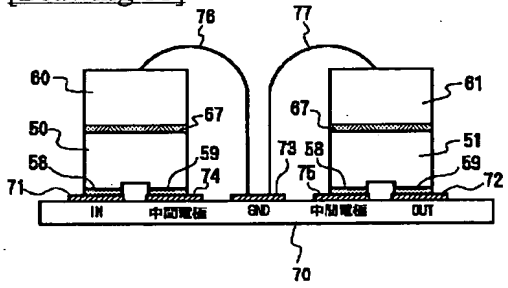
[Drawing 9]



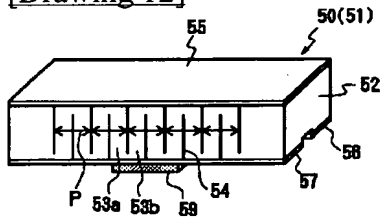
[Drawing 10]



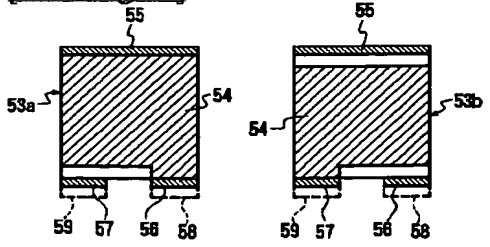
[Drawing 11]



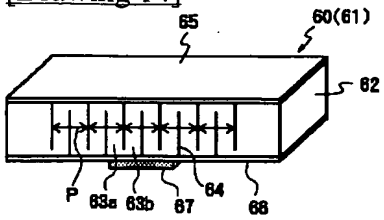
[Drawing 12]



[Drawing 13]



[Drawing 14]



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9/17		9/17	Ｄ	

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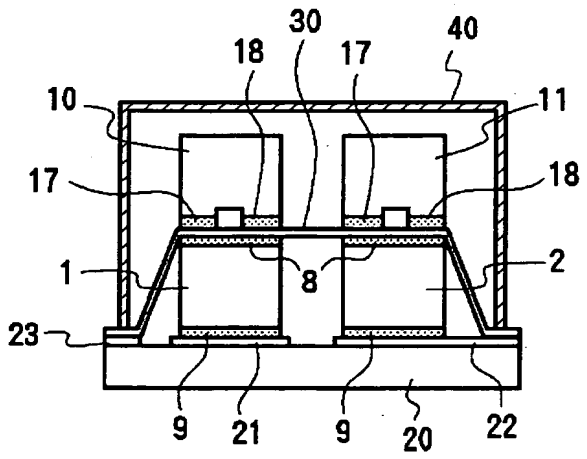
最終頁に続く

(54)【発明の名称】　ラダー型フィルタ

(57)【要約】
【課題】基板を小型化できるとともに、製造が簡単で信頼性の高いラダー型フィルタを提供する。
【解決手段】基板２０の上に搭載された長さ振動を利用した直列共振子１，２と、表裏面に接続電極が形成された配線フィルム３０と、配線フィルムを介して直列共振子の上に積み重ねて配置された長さ振動を利用した並列共振子１０，１１とを備える。直列共振子１，２の下面電極の長さ方向中央部を基板２０の第１のパターン電極の上に電気的に接続固定し、直列共振子１，２の上面電極の長さ方向中央部の上に配線フィルム３０の第１の接続電極に電気的に接続し、並列共振子１０，１１の第１の電極の長さ方向中央部を配線フィルム３０の第２の接続電極の上に電気的に接続し、並列共振子１０，１１の第２の電極の長さ方向中央部を配線フィルム３０の第３の接続電極の上に電気的に接続する。配線フィルム３０の第２の接続電極を基板２０の第２のパターン電極に接続し、配線フィルム３０の第３の接続電極を基板２０の第３のパターン電極に接続する。



1

【特許請求の範囲】

【請求項１】上面に第１～第３のパターン電極が形成された基板と、基板の上に搭載され、圧電体の上下面に対向する電極を有する長さ振動を利用した直列共振子と、裏面に第１の接続電極が形成され、表面に第１の接続電極と導通する第２の接続電極と、第３の接続電極とが形成された配線フィルムと、配線フィルムを介して直列共振子の上に積み重ねて配置され、圧電体の下面に第１，第２の電極を有する長さ振動を利用した並列共振子と、直列共振子の下面電極の長さ方向中央部を基板の第１のパターン電極の上に電気的に接続固定する第１の接続手段と、直列共振子の上面電極の長さ方向中央部の上に配線フィルムの第１の接続電極に電気的に接続固定する第２の接続手段と、並列共振子の第１の電極の長さ方向中央部を配線フィルムの第２の接続電極の上に電気的に接続固定する第３の接続手段と、並列共振子の第２の電極の長さ方向中央部を配線フィルムの第３の接続電極の上に電気的に接続固定する第４の接続手段と、を備え、上記配線フィルムの第２の接続電極は基板の第２のパターン電極に接続され、上記配線フィルムの第３の接続電極は基板の第３のパターン電極に接続されていることを特徴とするラダー型フィルタ。

【請求項２】上記直列共振子は、長さ方向に圧電体層と内部電極とを積層した柱状の基体と、基体の対向する上下面において上記内部電極と交互に接続されるように形成される２つの外部電極とを含み、圧電体層は基体の長さ方向に分極されていることを特徴とする請求項１に記載のラダー型フィルタ。

【請求項３】上記並列共振子は、長さ方向に圧電体層と内部電極とを積層した柱状の基体と、基体の下面において上記内部電極と交互に接続されるように形成される２つの外部電極とを含み、圧電体層は基体の長さ方向に分極されていることを特徴とする請求項１または２に記載のラダー型フィルタ。

【請求項４】上面に第１～第３のパターン電極が形成された基板と、基板の上に搭載され、圧電体の下面に第１，第２の電極を有し、上面に第２の電極と導通する第３の電極を有する長さ振動を利用した直列共振子と、直列共振子の上に積み重ねて配置され、圧電体の上下面に対向する電極を有する長さ振動を利用した並列共振子と、直列共振子の下面の第１，第２電極の長さ方向中央部を基板の第１，第２のパターン電極にそれぞれ電気的に接続固定する第１，第２の接続手段と、直列共振子の上面の第３電極の長さ方向中央部を並列共振子の下面電極の長さ方向中央部と電気的に接続固定する第３の接続手段と、並列共振子の上面電極の長さ方向中央部を基板の第３のパターン電極と電気的に接続する第４の接続手段と、を備えたことを特徴とするラダー型フィルタ。

【請求項５】上記直列共振子は、長さ方向に圧電体層と内部電極とを積層した柱状の基体と、基体の対向する上

2

下面において上記内部電極と交互に接続されるように形成される３つの外部電極とを含み、圧電体層は基体の長さ方向に分極されていることを特徴とする請求項４に記載のラダー型フィルタ。

【請求項６】上記並列共振子は、長さ方向に圧電体層と内部電極とを積層した柱状の基体と、基体の対向する上下面において上記内部電極と交互に接続されるように形成される２つの外部電極とを含み、圧電体層は基体の長さ方向に分極されていることを特徴とする請求項４または５に記載のラダー型フィルタ。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は長さ振動を利用した圧電素子を用いたラダー型フィルタに関するものである。

【０００２】

【従来の技術】従来、長さ方向振動モードを利用した直列共振子および並列共振子を用いたラダー型フィルタが提案されている（特開平９－２７０６６８号公報）。このラダー型フィルタは、入力用，出力用およびアース用のパターン電極が形成された基板と、基板の上面に搭載された直列共振子および並列共振子と、これら共振子を覆うように基板に接着されるキャップとを備えたものである。直列共振子は対向する左右の側面に電極を有しており、これら電極は基板の入力用および出力用パターン電極と導電性接着剤により接続固定されている。また、並列共振子は上下面に電極を有するものであり、その下面電極が基板の出力用パターン電極に導電性接着剤により接続固定され、上面電極が基板のアース用パターン電極と金属ワイヤによって電気的に接続されている。このように直列共振子と並列共振子とを基板上に平面状に並列配置すると、基板の配置スペースが大きくなる。特に、複数段のラダーを構成したラダー型フィルタの場合には、直列共振子および並列共振子がそれぞれ複数個設けられるので、基板が一層大型となり、ラダー型フィルタとしても大型になる欠点がある。

【０００３】このような欠点を解消するため、上記公報には、直列共振子の上に並列共振子を積み重ねて配置したものも提案されている（上記公報の図６，図９参照）。この場合には、上記と同様に直列共振子は対向する左右の側面に電極を有しており、これら電極は基板の入力用および出力用パターン電極と導電性接着剤により接続固定されている。また、並列共振子は上下面に電極を有するものであり、その下面電極が直列共振子の出力側の電極と導通するように、導電性接着剤により直列共振子の上に積層して接着され、上面電極が基板のアース用パターン電極と金属ワイヤによって電気的に接続されている。この場合には、直列共振子と並列共振子とが上下に積み重ねられるので、基板の配置スペースが小さくなり、小型のラダー型フィルタを構成できる。

【０００４】

【発明が解決しようとする課題】しかしながら、上記構造のラダー型フィルタの場合、直列共振子が左右の側面に電極を有する圧電素子であるため、直列共振子の出力側の電極だけでなく入力側の電極も、その上に接着される並列共振子の下面電極と近接することになる。そのため、並列共振子の下面電極と直列共振子の出力側の電極とを導電性接着剤により接続するとき、並列共振子の下面電極が直列共振子の入力側の電極とも導通してしまう恐れがあった。したがって、並列共振子の下面電極と直列共振子の入力側の電極とが導通しないように格別の処理が必要となり、製造コストを上昇させる問題があった。また、直列共振子の出力側の電極と、その上に接着される並列共振子の下面電極とが直交方向にあるため、これらの電極を確実に接続するためには、直列共振子の上面に出力側の電極と導通する接続用電極を形成するといった追加処理が必要となる場合があり、一層のコスト上昇を招く可能性があった。同様に、直列共振子の入力側および出力側の電極と基板の入力用および出力用パターン電極も直交方向にあるため、そのまま接着したのでは接着面積が小さい。そのため、これらの電極を確実に接続するために、導電性接着剤をディスペンスなどによって塗布する必要があり、生産性を低下させる可能性があった。

【０００５】そこで、本発明の目的は、基板を小型化できるとともに、製造が簡単で信頼性の高いラダー型フィルタを提供することにある。

【０００６】

【課題を解決するための手段】上記目的は、請求項１または４に記載の発明によって達成される。すなわち、請求項１に記載の発明は、上面に第１～第３のパターン電極が形成された基板と、基板の上に搭載され、圧電体の上下面に対向する電極を有する長さ振動を利用した直列共振子と、裏面に第１の接続電極が形成され、表面に第１の接続電極と導通する第２の接続電極と、第３の接続電極とが形成された配線フィルムと、配線フィルムを介して直列共振子の上に積み重ねて配置され、圧電体の下面に第１，第２の電極を有する長さ振動を利用した並列共振子と、直列共振子の下面電極の長さ方向中央部を基板の第１のパターン電極の上に電気的に接続固定する第１の接続手段と、直列共振子の上面電極の長さ方向中央部の上に配線フィルムの第１の接続電極に電気的に接続固定する第２の接続手段と、並列共振子の第１の電極の長さ方向中央部を配線フィルムの第２の接続電極の上に電気的に接続固定する第３の接続手段と、並列共振子の第２の電極の長さ方向中央部を配線フィルムの第３の接続電極の上に電気的に接続固定する第４の接続手段と、を備え、上記配線フィルムの第２の接続電極は基板の第２のパターン電極に接続され、上記配線フィルムの第３の接続電極は基板の第３のパターン電極に接続されていることを特徴とするラダー型フィルタである。

【０００７】請求項４に記載の発明は、上面に第１～第３のパターン電極が形成された基板と、基板の上に搭載され、圧電体の下面に第１，第２の電極を有し、上面に第２の電極と導通する第３の電極を有する長さ振動を利用した直列共振子と、直列共振子の上に積み重ねて配置され、圧電体の上下面に対向する電極を有する長さ振動を利用した並列共振子と、直列共振子の下面の第１，第２電極の長さ方向中央部を基板の第１，第２のパターン電極にそれぞれ電気的に接続固定する第１，第２の接続手段と、直列共振子の上面の第３電極の長さ方向中央部を並列共振子の下面電極の長さ方向中央部と電気的に接続固定する第３の接続手段と、並列共振子の上面電極の長さ方向中央部を基板の第３のパターン電極と電気的に接続する第４の接続手段と、を備えたことを特徴とするラダー型フィルタである。

【０００８】請求項１にかかる発明の場合、基板の上に直列共振子が搭載され、その上に配線フィルムを介して並列共振子が積み重ねて配置される。そのため、直列共振子と並列共振子とを基板上に平面状に配置した場合に比べて、基板の配置スペースが小さくなり、小型のラダー型フィルタを構成できる。また、直列共振子は上下面に電極を有する共振子であり、その下面電極を基板の第１のパターン電極の上に対面させて、第１の接続手段によって接続固定してあるので、電気的接続が確実でかつ機械的強度も高い。そして、直列共振子の上面電極の上に配線フィルムの第１の接続電極を第２の接続手段により電気的に接続固定し、並列共振子の下面の第１の電極を配線フィルムの第２の接続電極の上に第３の接続手段により接続し、さらに並列共振子の下面の第２の電極を配線フィルムの第３の接続電極の上に第４の接続手段により接続してあるので、すべてが上下方向に対面接続すればよく、接続作業が簡単でかつ確実である。そして、配線フィルムの第２の接続電極を基板の第２のパターン電極に、配線フィルムの第３の接続電極を基板の第３のパターン電極にそれぞれ接続するようになっているので、金属ワイヤなどを用いずに電気的な接続を行うことができる。そのため、ワイヤ接続の場合に比べて製品の全高を低くできる。また、直列共振子を基板に固定するための第１の接続手段として、柔らかい導電性接着剤を用いることが多いが、ワイヤボンディングを行う場合には超音波が導電性接着剤を介して逃げ、接合が困難になる。これに対し、配線フィルムを用いる場合には、このような問題がない。なお、第１～第４の接続手段としては、例えば導電性接着剤を用いることができる。また、配線フィルムとしては、例えばポリイミド配線フィルムを用いることができる。

【０００９】直列共振子としては、請求項２のように、長さ方向に圧電体層と内部電極とを積層した柱状の基体と、基体の対向する上下面において上記内部電極と交互

5

に接続されるように形成される２つの外部電極とを含み、圧電体層は基体の長さ方向に分極されたものを使用してもよい。このような積層型の圧電素子の場合、分極方向、電界方向、振動方向の一致した圧電縦効果を利用しているので、分極方向、電界方向と振動方向とが異なる圧電横効果を利用した圧電素子に比べて、電気機械結合係数を大きくすることができる。同様に、並列共振子として、請求項３のように、長さ方向に圧電体層と内部電極とを積層した柱状の基体と、基体の下面において上記内部電極と交互に接続されるように形成される２つの外部電極とを含み、圧電体層は基体の長さ方向に分極されたものを使用してもよい。積層型の圧電素子の場合、内部電極の引き出し方向を工夫するだけで、１面に入出力用の外部電極を簡単に形成できる。

【００１０】請求項４にかかる発明の場合、基板の上に直列共振子が搭載され、その上に並列共振子が積み重ねて配置される。そのため、直列共振子と並列共振子とを基板上に平面状に配置した場合に比べて、基板の配置スペースが小さくなり、小型のラダー型フィルタを構成できる。また、直列共振子は下面に第１，第２の電極を有し、上面に第２の電極と導通する第３の電極を有する共振子であり、その下面電極を基板の第１，第２のパターン電極に対面させて第１，第２の接続手段により接続固定したので、電気的接続が確実でかつ機械的強度も高い。同様に、直列共振子の上面の第３電極の上に並列共振子の下面電極を対面させて第３の接続手段により接続固定したので、直列共振子と並列共振子の接合強度も高くなる。そのため、落下衝撃などに対しても耐久性の高いラダー型フィルタを得ることができる。なお、第１～第３の接続手段としては、例えば導電性接着剤を用いることができる。また、第４の接続手段としては、請求項１と同様な配線フィルムを用いてもよいし、金属ワイヤを用いることもできる。

【００１１】請求項５のように、直列共振子は、長さ方向に圧電体層と内部電極とを積層した柱状の基体と、基体の対向する上下面において上記内部電極と交互に接続されるように形成される３つの外部電極とを含み、圧電体層は基体の長さ方向に分極されているものを使用することができる。さらに、請求項６のように、並列共振子は、長さ方向に圧電体層と内部電極とを積層した柱状の基体と、基体の対向する上下面において上記内部電極と交互に接続されるように形成される２つの外部電極とを含み、圧電体層は基体の長さ方向に分極されているものを使用することができる。このように直列共振子および並列共振子として、積層型の圧電素子を用いることで、電気機械結合係数を大きくすることができる。

【００１２】

【発明の実施の形態】図１～図８は本発明にかかるラダー型フィルタの第１実施例を示す。このラダー型フィルタは、図４に示すように、２個の直列共振子１，２と、

6

２個の並列共振子１０，１１とを含む。なお、２０は基板、３０は配線フィルム、４０はキャップである。

【００１３】直列共振子１，２は長さ振動モードを利用した同一の圧電素子であり、図５に示すように直方体形状の基体３を含む。基体３は、圧電セラミック材料よりなる２種類の圧電体層４ａ，４ｂを交互に積層し、基体３の上下両側面において内部電極５を交互に露出させたものである。図５に矢印Ｐで示すように、１つの内部電極５の両側の圧電体層４ａ，４ｂの分極軸が互いに逆向きとなるように基体３の長手方向に分極されている。但し、基体３の両端部は分極されていない。内部電極５が露出した上下面には外部電極６，７が形成され、内部電極５が１つおきに外部電極６，７と接続される。外部電極６，７の長さ方向中央部（ノード部）には、凸状の導電性支持体８，９が固定されている。この実施例の導電性支持体８，９は、導電性フィラーを含有するウレタン樹脂を外部電極６，７上に所定厚みで塗布したうえ硬化させたものである。なお、導電性支持体８，９は、後述する導電性接着剤と共用することにより、省略可能である。

【００１４】上記直列共振子１，２では、外部電極６，７が入，出力電極として使用される。このとき、基体３の両端部を除く部分では、隣合う内部電極５間に電界が印加されるため、圧電的に活性となるが、基体３の両端部では基体３が分極されず、しかも基体３の両端面に電極が形成されていないので、電界が印加されず、圧電的に不活性となる。したがって、外部電極６，７間に信号を与えることにより、基体３の長手方向の交流電界が活性部の各圧電体層４ａ，４ｂに印加され、各圧電体層４ａ，４ｂに伸縮駆動力が発生し、全体として基体３に長さ振動モードの基本振動が励振される。なお、基体３の両端部に不活性部を設けたが、この不活性部は必須のものではなく、基体３全体を活性部としてもよい。

【００１５】並列共振子１０，１１は長さ振動モードを利用した同一の圧電素子であり、図６に示すように直方体形状の基体１２を含む。基体１２は、図７に示すような圧電セラミック材料よりなる２種類の圧電体層１３ａ，１３ｂを交互に積層し、基体１２の一面において内部電極１４を交互に露出させたものである。図６に矢印Ｐで示すように、１つの内部電極１４の両側の圧電体層１３ａ，１３ｂの分極軸が互いに逆向きとなるように基体１２の長手方向に分極されている。但し、基体１２の両端部は分極されていない。内部電極１４が露出した下面（図６，図７では上下反転して図示してある）には２本の外部電極１５，１６が長手方向に平行に形成され、内部電極１４が１つおきに外部電極１５，１６と接続される。なお、この実施例では、外部電極１５，１６の間に、基体１２の長さ方向に延びる溝１９が形成されているが、この溝１９は必ずしも必要ではない。外部電極１５，１６の長さ方向中央部（ノード部）には、凸状の導

電性支持体１７，１８が固定されている。この実施例の導電性支持体１７，１８は、導電性フィラーを含有するウレタン樹脂を外部電極１５，１６上に所定厚みで塗布したうえ硬化させたものである。なお、導電性支持体１７，１８は、後述する導電性接着剤と共用することにより、省略可能である。並列共振子１０，１１の場合も、直列共振子１，２と同様の原理で長さ振動モードの基本振動が励振される。

【００１６】基板２０はアルミナセラミックス，ガラスセラミック，ガラスエポキシ樹脂、耐熱性樹脂等からなる長方形の絶縁性薄板であり、基板２０の上面には、図８に示すように入力用パターン電極２１、出力用パターン電極２２、アース用パターン電極２３およびダミー電極２４がスパッタリング，蒸着，印刷などの公知の手法で形成されている。各パターン電極２１～２４の外部接続部は基板２０の側縁を介して裏面側へ延設されている。入力用パターン電極２１および出力用パターン電極２２のランド部２１ａ，２２ａには、直列共振子１，２の下面側の外部電極７に固定された導電性支持体９が、導電性接着剤（図示せず）を介して接着固定されている。導電性接着剤としては、例えばＡｇフィラーを含有するエポキシ系接着剤を用いることができる。これにより、直列共振子１の外部電極７が基板２０の入力用パターン電極２１に、直列共振子２の外部電極７が基板２０の出力用パターン電極２２にそれぞれ電気的に接続され、かつ機械的に固定される。特に、直列共振子１，２はその長さ方向中央部（ノード部）が基板２０に固定され、両端部は基板２０と隙間をもって支持されるので、直列共振子１，２の長さ振動が阻害されることがない。

【００１７】配線フィルム３０は、例えばポリイミドフィルムなどの可撓性を有する絶縁フィルムの表裏面に、銅箔などよりなる複数の接続電極３１～３４を形成したものである。図９に示すように、裏面の接続電極３１は配線フィルム３０の中央部に形成され、直列共振子１，２の上面の外部電極６の上に形成された導電性支持体８と導電性接着剤（図示せず）を介して接続固定される。裏面の接続電極３１は、スルーホール電極３５を介して表面の接続電極３２と導通している。配線フィルム３０の表面には、接続電極３２の他に、アース用接続電極３３と出力用接続電極３４とが形成されている。アース用接続電極３３は配線フィルム３０の一端部まで伸び、ここでスルーホール電極３６を介して裏面側の電極３７と導通している。また、出力用接続電極３４は配線フィルム３０の他端部へ伸び、ここでスルーホール電極３８を介して裏面側の電極３９と導通している。配線フィルム３０の接続電極３２には、並列共振子１０の一方の外部電極１５が導電性支持体１７および導電性接着剤（図示せず）を介して接続され、接続電極３３には他方の外部電極１６が導電性支持体１８および導電性接着剤（図示せず）を介して接続される。また、接続電極３３には、並列共振子１１の一方の外部電極１５が導電性支持体１７および導電性接着剤（図示せず）を介して接続され、接続電極３４には他方の外部電極１６が導電性支持体１８および導電性接着剤（図示せず）を介して接続される。そして、配線フィルム３０の一端部裏面に形成された電極３７が基板２０のアース用パターン電極２３に導電性接着剤などによって接続固定され、配線フィルム３０の他端部裏面に形成された電極３９が基板２０の出力用パターン電極２２に導電性接着剤などによって接続固定される。

【００１８】基板２０上には共振子１，２，１０，１１を覆うキャップ４０の開口部が絶縁性接着剤（図示せず）により接着され、共振子１，２，１０，１１の周囲が封止されている。この実施例のキャップ４０は金属板をプレス成形したものであるが、樹脂製キャップあるいはセラミック製キャップであってもよい。この実施例では、キャップ４０を基板２０に接着する際に、配線フィルム３０の両端部をキャップ４０と基板２０とで挟着しており、配線フィルム３０が基板２０から外れるのを防止している。

【００１９】上記実施例のラダー型フィルタの場合、基板２０の上に直列共振子１，２が固定され、その上に配線フィルム３０を介して並列共振子１０，１１が積み重ねて配置されるので、直列共振子１，２と並列共振子１０，１１とを基板２０上に平面状に配置した場合に比べて、基板２０の配置スペースが小さくなり、小型のラダー型フィルタを構成できる。また、直列共振子１，２は上下面に電極を有する共振子であり、その下面電極７を基板２０の入力用パターン電極２１および出力用パターン電極２２のランド部２１ａ，２２ａに対面させて、導電性支持体９または導電性接着剤によって接続固定してあるので、電気的接続が確実でかつ接合強度も高い。そして、直列共振子１，２の上に配線フィルム３０を介して並列共振子１０，１１を固定し、配線フィルム３０の表裏面に形成された接続電極を介して、直列共振子１，２と並列共振子１０，１１との相互接続、並列共振子１０，１１と基板２０のパターン電極２２，２３との相互接続を行うので、接続が確実になり、かつワイヤボンディングを用いずに基板２０と接続できるので、ラダー型フィルタを低背化できるという効果を奏する。さらに、並列共振子１０，１１を予め配線フィルム３０に固定しておき、２素子同時に直列共振子１，２上にマウントするようにすれば、素子の位置ずれや高さばらつきに対して、精度向上が図れる利点がある。なお、図３に示すように、基板２０上に直列共振子１，２の傾きを防止する弾性支持体２５を固定してもよい。この場合には、直列共振子１，２と基板２０との接着が剥離するのを効果的に防止できる。なお、弾性支持体２５はゴム弾性を有するので、直列共振子１，２と接触することがあっても、振動を阻害することが少ない。

【００２０】図１０～図１４は本発明にかかるラダー型フィルタの第２実施例を示す。このラダー型フィルタも、２個の直列共振子５０，５１と、２個の並列共振子６０，６１とを含み、その回路は図４と同様である。なお、７０は基板、８０はキャップである。

【００２１】直列共振子５０，５１は長さ振動モードを利用した同一の圧電素子であり、図１２に示すように直方体形状の基体５２を含む。基体５２は、図１３に示すような圧電セラミック材料よりなる２種類の圧電体層５３ａ，５３ｂを交互に積層し、基体５２の上下両側面において内部電極５４を交互に露出させたものである。一方の圧電体層５３ａでは、内部電極５４が下面の一端側と上面とに露出するように形成され、他方の圧電体層５３ｂでは、内部電極５４が下面の他端側にのみ露出するように形成されている。図１２に矢印Ｐで示すように、１つの内部電極５４の両側の圧電体層５３ａ，５３ｂの分極軸が互いに逆向きとなるように基体５２の長手方向に分極されている。但し、基体５２の両端部は分極されていない。内部電極５４が露出した上面には外部電極５５が形成され、下面には２個の外部電極５６，５７が形成され、内部電極５４が１つおきに外部電極５５，５６，５７と接続される。具体的には、圧電体層５３ａの内部電極５４は上面の外部電極５５と下面の一方の外部電極５６とに接続され、圧電体層５３ｂの内部電極５４は下面の他方の外部電極５７に接続される。下面側の外部電極５６，５７の長さ方向中央部（ノード部）には、凸状の導電性支持体５８，５９が固定されている。この実施例の導電性支持体５８，５９も、導電性フィラーを含有するウレタン樹脂を外部電極５６，５７上に所定厚みで塗布したうえ硬化させたものである。なお、導電性支持体５８，５９は、後述する導電性接着剤と共用することにより、省略可能である。

【００２２】並列共振子６０，６１は、図５に示した直列共振子１，２と同様の構造を有する長さ振動モードを利用した圧電素子である。すなわち、図１４に示すように、直方体形状の基体６２は、圧電セラミック材料よりなる２種類の圧電体層６３ａ，６３ｂを交互に積層し、基体６２の上下両側面において内部電極６４を交互に露出させたものである。図１４に矢印Ｐで示すように、１つの内部電極６４の両側の圧電体層６３ａ，６３ｂの分極軸が互いに逆向きとなるように基体６２の長手方向に分極されている。内部電極６４が露出した上下面には外部電極６５，６６が形成され、内部電極６４が１つおきに外部電極６５，６６と接続される。下面の外部電極６６の長さ方向中央部（ノード部）には、凸状の導電性支持体６７が固定されている。なお、導電性支持体６７は、後述する導電性接着剤と共用することにより、省略可能である。なお、直列共振子５０，５１および並列共振子６０，６１も、直列共振子１，２と同様の原理で長さ振動モードの基本振動が励振される。

【００２３】基板７０には、入力用パターン電極７１、出力用パターン電極７２、アース用パターン電極７３、中間電極７４，７５が形成されており、中間電極７４，７５は図示しないパターン配線を介して互いに導通している。基板７０の入力用パターン電極７１と中間電極７４の上には、直列共振子５０の下面の外部電極５６，５７が導電性支持体５８，５９および導電性接着剤（図示せず）を介して接続固定される。同様に、基板７０の中間電極７５と出力用パターン電極７２の上には、直列共振子５１の下面の外部電極５６，５７が導電性支持体５８，５９および導電性接着剤（図示せず）を介して接続固定される。

【００２４】また、直列共振子５０の上面電極５５には、並列共振子６０の下面電極６６が導電性支持体６７および導電性接着剤を介して接続固定され、直列共振子５１の上面電極５５には、並列共振子６１の下面電極６６が導電性支持体６７および導電性接着剤を介して接続固定される。そして、並列共振子６０，６１の上面電極６５はそれぞれ金属ワイヤ７６，７７を介してアース用パターン電極７３と接続される。このようにして、図４と同様な回路構造を有するラダー型フィルタを得ることができる。

【００２５】なお、この実施例では、アース用パターン電極７３を基板７０の中央部に形成し、並列共振子６０，６１の上面電極６５をそれぞれ金属ワイヤ７６，７７を介してアース用電極７３と接続したが、アース用パターン電極７３が基板７０の端部に形成されている場合には、並列共振子６０，６１の上面電極６５同士を金属ワイヤで接続し、一方の並列共振子の上面電極からアース用パターン電極７３へ金属ワイヤで接続してもよい。さらに、並列共振子６０，６１の上面電極６５をアース用パターン電極７３と接続するために、金属ワイヤ７６，７７に代えて、第１実施例で示した配線フィルム３０を用いることも可能である。

【００２６】第２実施例のラダー型フィルタの場合、第１実施例と同様に、直列共振子５０，５１の上に並列共振子６０，６１を積み重ねて配置したので、低面積化が図れ、小型のラダー型フィルタを実現できる。また、金属ワイヤ７６，７７を用いているので、第１実施例に比べて若干全高が高くなる可能性があるが、直列共振子５０，５１の上に並列共振子６０，６１を直接固定するので、支持強度が高くなり、落下衝撃に対する耐久性が向上する。特に、並列共振子６０，６１の下面電極６６が直列共振子５０，５１の上面電極５５に対面させて接着され、直列共振子５０，５１の下面電極５６，５７が基板７０のパターン電極７１，７４および７５，７２に対面させて接着されるので、中央部しか支持できない長さ振動モード素子であっても、接着強度および電気的信頼性を確保できる。

【００２７】本発明における基板とは、実施例に記載の

ような平板形状である必要はなく、周囲に側壁を有する凹状ケースであってもよいし、内部に直列共振子および並列共振子を安定に保持するための支持部などを備えたものでもよい。上記実施例では、直列共振子および並列共振子として、複数の圧電体層を積層することにより、全体として長さ振動モード素子を構成した積層型の圧電素子を用いた例を説明したが、これに限るものではなく、１枚の圧電基板の両主面または一側面に電極を形成した長さ振動モード素子でもよい。さらに、本発明のラダー型フィルタは、２個の直列共振子と２個の並列共振子とを用いたものに限らず、１個の直列共振子と１個の並列共振子とを用いたものや、３個以上の直列共振子と３個以上の並列共振子とを用いたものでもよい。

【００２８】

【発明の効果】以上の説明で明らかなように、請求項１に係る発明によれば、基板の上に直列共振子を搭載し、その上に配線フィルムを介して並列共振子を積み重ねて配置したので、直列共振子と並列共振子とを基板上に平面状に配置した場合に比べて、基板の配置スペースが小さくなり、小型のラダー型フィルタを構成できる。また、直列共振子と基板との接続固定、直列共振子と配線フィルムとの接続、および配線フィルムと並列共振子との接続は、すべて対面する電極同士を導電性接着剤などの接続手段によって接続するものであるから、電気的接続が簡単かつ確実であり、接合強度も高い。さらに、配線フィルムを用いて直列共振子および並列共振子と基板のパターン電極との電気的接続を行うようにしたので、金属ワイヤなどを用いずに電気的な接続を行うことができ、製品の全高を低くできるとともに、接合の信頼性を高めることができる。

【００２９】請求項４に係る発明によれば、基板の上に直列共振子を搭載し、その上に並列共振子を積み重ねて配置したので、直列共振子と並列共振子とを基板上に平面状に配置した場合に比べて、基板の配置スペースが小さくなり、小型のラダー型フィルタを構成できる。また、直列共振子と基板との接続固定、直列共振子と並列共振子との接続は、対面する電極同士を導電性接着剤などの接続手段によって接続するものであるから、電気的接続が簡単かつ確実であり、接合強度も高いという効果を奏する。

【図面の簡単な説明】

【図１】本発明にかかるラダー型フィルタの第１実施例の斜視図である。

【図２】図１のＸ－Ｘ線断面図である。

【図３】図１のＹ－Ｙ線断面図である。

【図４】図１に示すラダー型フィルタの回路図である。

【図５】図１のラダー型フィルタに用いられる直列共振子の斜視図である。

【図６】図１のラダー型フィルタに用いられる並列共振子の斜視図である。

【図７】図６の並列共振子を構成する圧電体層の正面図である。

【図８】図１のラダー型フィルタに用いられる基板の平面図である。

【図９】図１のラダー型フィルタに用いられる配線フィルムの表面図および裏面図である。

【図１０】本発明にかかるラダー型フィルタの第２実施例の斜視図である。

【図１１】図１０に示すラダー型フィルタのキャップを省略した側面図である。

【図１２】図１０のラダー型フィルタに用いられる直列共振子の斜視図である。

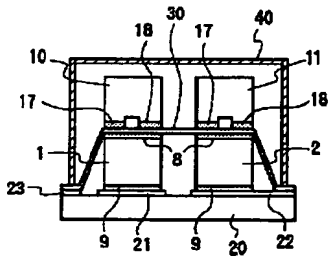
【図１３】図１２の直列共振子を構成する圧電体層の正面図である。

【図１４】図１０のラダー型フィルタに用いられる並列共振子の斜視図である。

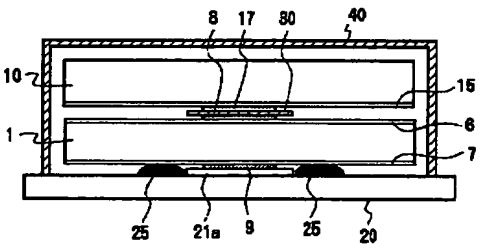
【符号の説明】

１，２，５０，５１	直列共振子
１０，１１，６０，６１	並列共振子
２０，７０	基板
３０	配線フィルム
４０，８０	キャップ

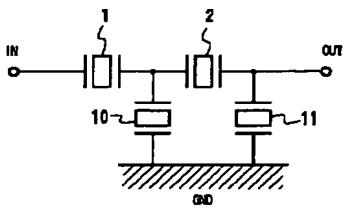
【図２】



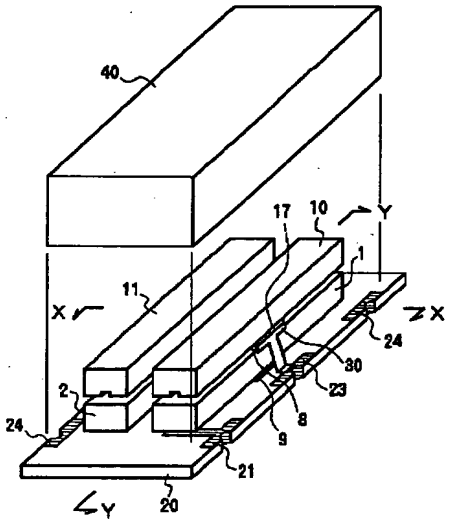
【図３】



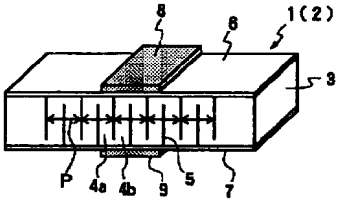
【図４】



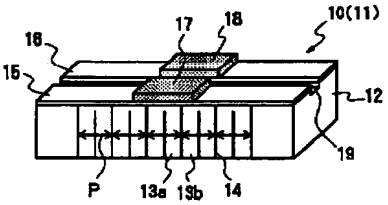
【図１】



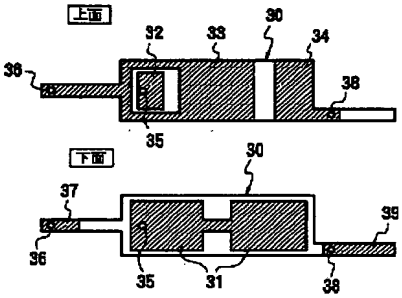
【図５】



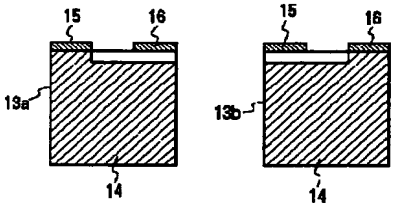
【図６】



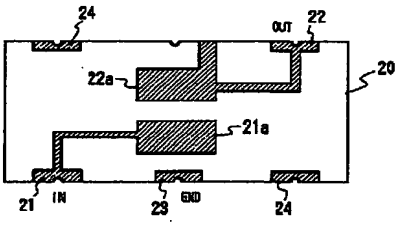
【図９】



【図７】



【図８】



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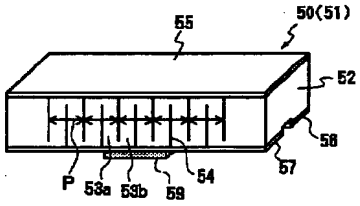
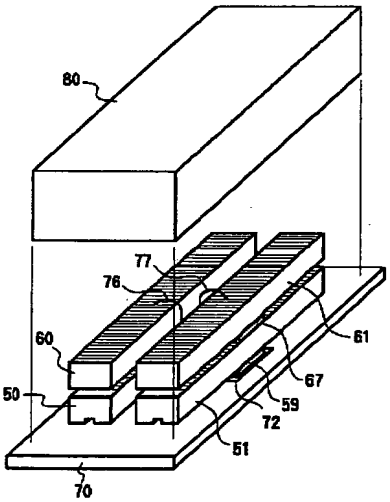
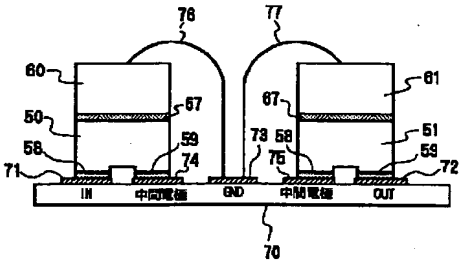


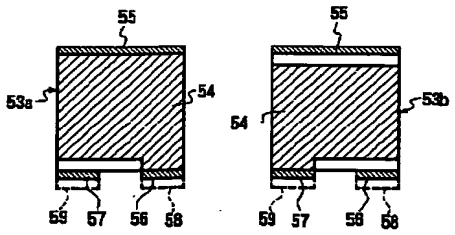
【図１０】

【図１１】

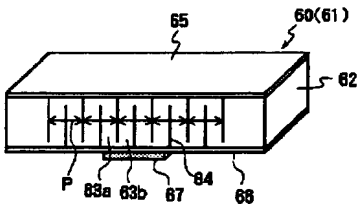




【図１３】



【図１４】



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拒絶理由通知書

特許出願の番号	特願２００４－０４１４６９
起案日	平成１８年　３月２９日
特許庁審査官	井上　弘亘　　３２４８　５W００
特許出願人代理人	上柳　雅誉（外　２名）　様
適用条文	第２９条第１項、第２９条第２項

この出願は、次の理由によって拒絶をすべきものである。これについて意見があれば、この通知書の発送の日から６０日以内に意見書を提出して下さい。

理　由

Ａ．この出願の下記の請求項１，２，４，５，７に係る発明は、その出願前に日本国内又は外国において、頒布された下記の刊行物１に記載された発明又は電気通信回線を通じて公衆に利用可能となった発明であるから、特許法第２９条第１項第３号に該当し、特許を受けることができない。
Ｂ．この出願の下記の請求項１－５，７に係る発明は、その出願前日本国内又は外国において頒布された下記の刊行物１－３に記載された発明に基いて、その出願前にその発明の属する技術の分野における通常の知識を有する者が容易に発明をすることができたものであるから、特許法第２９条第２項の規定により特許を受けることができない。

記

１．特開２０００－１５１２８３号公報
２．特開２００１－３５８５５９号公報
３．特開平１０－１７３４７５号公報

[理由Ａ]
請求項：１，２，４，５，７
刊行物：１
備考　：
　請求項１，２，４，５，７に係る発明と、上記刊行物１（特に、第１２０－１
２７行、第８－１１図等参照）に示される発明とは同一である。

[理由Ｂ]
請求項：１－５，７
刊行物：１
備考　：
　請求項１，２，４，５，７に係る発明と、上記刊行物１（特に、第１２０－１
２７行、第８－１１図等参照）に示される発明とには格別な差異は認められない
。
　また、４つ以上の外部電極が設けられた圧電振動子において、外部端子以外の
端子の一つを、グランド端子、他の一つをダミー端子とすることは、周知の技術
（例えば、上記刊行物２（特に、第００１６段落及び第８図等参照）、上記刊行
物３（特に、第００１９段落及び第１、２図等参照））である。
　よって、上記刊行物１に示される発明においても、外部端子以外の２端子の一
方を、グランド端子、もう一方をダミー端子とすることは、当業者が容易に想到
し得ることである。

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・先行技術文献　特開２００２－５０９２９号公報、特開２００１－１８９６３
６号公報
　この先行技術文献調査結果の記録は、拒絶理由を構成するものではない。